SCIENTIFIC BOOKS

A History of Chemistry. By ERNST VON MEYER, translated by GEORGE MCGOWAN. Third English edition. New York, The Macmillan Co. 1906. Pp. xxvii + 691.

Vortraege über die Entwickelungsgeschichte der Chemie. By A. LADENBURG. Fourth German edition. Braunschweig, Vieweg und Sohn. 1907. Pp. xiv + 418.

A History of Chemistry. By F. P. ARMITAGE. New York, Longmans, Green and Co. 1906. Pp. xx + 266.

A History of Chemical Theories and Laws. By M. M. PATTISON MUIR. New York, John Wiley and Sons. 1907. Pp. xx + 555.

Abhandlungen und Vortraege zur Geschichte der Naturwissenschaften. By EDMUND O. VON LIPPMANN. Leipzig, Veit und Comp. 1906. Pp. xii + 590.

"Man is an animal that looks before and after," but the chemist is, of all men, the one who is most in danger of being so impressed by the activity of to-day as to find little time for looking backward. Yet the greatest chemists, almost without exception, have been students of the history of the science and in many instances their historical reading has influenced strongly the direction and even the quality of their work. It is true that the best source of inspiration is the reading of the original documents, but well-ordered general accounts of the development of the science, or of particular parts of it, are indispensable aids in the larger task, even if they can not replace it entirely. The works before us present the historical side of chemistry in different ways, and, far from being competitors, they supplement one another admirably. Von Meyer's is the most complete, but the mention of many things in very brief. Ladenburg covers much the same period but takes only the salient points. Armitage is briefer still, more highly colored and more lively. Muir follows only certain lines in the development of the science, but in these lines is fuller than von Meyer. Finally, von Lippmann provides us with a series of intensely interesting studies. He deals with single points or with the work of a particular man, and his subjects are as often in physics, or even literature or philology, as in chemistry.

The first and second editions of von Meyer's "History" have already been reviewed in SCIENCE, and its breadth and accuracy of treatment, the fullness of its references to sources of historical information, and the simplicity and directness of its style are well known to every chemist. Since the appearance of the first German (1888) and English (1891) editions the science has been advancing with ever-increasing strides and it has been becoming more and more difficult to disentangle from an overwhelming mass of facts the leading ideas of which these facts are in some sense the fruit. The author has endeavored to recognize these advances by means of special histories of each branch of the science, which follow the main history. In these, after a brief résumé of the main connections with the earlier history, already discussed in detail, he endeavors to trace the growth down to the date of the present edition. In this he is surprisingly successful, when the herculean nature of the task is considered.

The translator has done his work creditably, and the changes he has made, with the sanction of the author, are all useful. It is a pity, however, that these did not include the substitution of a reference to A. S. Couper's paper in the *Philosophical Magazine*, for the two French ones given in the German edition. If so many of our works on chemistry had not been borrowed from Germany, more of us would have escaped errors like that of trying to give a French pronunciation to the name of a Scotsman born in Kirkintulloch!

Ladenburg's "Lectures," which have reached their fourth German edition, are familiar in Dobbin's admirable translation. The period which they cover begins, practically, with Lavoisier, and the seventeenth lecture, prepared for the fourth edition, brings the book up to date. Evidences of the care with which the other sixteen lectures have been revised may be seen in almost every page. The lectures furnish a clear and interesting panorama of the progress of chemistry and hold

one's attention, without wearying it, from the first word to the last. While the work is not comparable with von Meyer's in size, yet, to the writer, the choice of material for illustration seems often to be happier. Perhaps no two chemists would make the same distribution of emphasis. But, in view of the theoretical and commercial importance of the work of Roberts Austen, von Jüptner, and Roozeboom on the allotropic forms of iron, for example, few would grudge the page which Ladenburg devotes to the matter, and hardly any chemist would side with von Meyer in ignoring these investigators and the subject entirely.

Armitage's "History" begins at the beginning, or perhaps even earlier. E. von Meyer starts with the Egyptians, but Armitage's opening sentence traces the science back to "the dawn of human intelligence." To make up for this unusual extension in one direction, the book stops rather unexpectedly with what the author might call the morning of the periodic system. Only a few pages, in an earlier chapter on stereo-chemistry, deal with anything later than this epoch. While the book is in some ways immature, it has distinct merits. Its vocabulary of breezy adverbs and adjectives, its rhetorical questions, and its semi-familiar way of interpreting the feelings, as well as the opinions, of the fathers of the science are an effectual antidote to the "dryness" which is apt to settle down on history.

> Berzelius, in reviewing the whole subject [of atomic weights], became oppressed with the unscientific, slapdash manner in which it had been approached by his contemporaries. Was there no general principle . . . which might guide one right in the choice of atomic weights from the many values submitted?

Quotations, brief and to the point, are introduced aptly, and the men are characterized successfully without waste of words. Taking it all in all, the book may be recommended to those who wish a brief and readable account of the men who have made chemistry, of how they made it, and of what they made it. It is too bad, however, that in a book by a Briton, poor Couper should be connected exclusively, and so explicitly, with a French journal, and should be made even more like a Frenchman than usual by an error in his initials—*M.* S. Couper!

Professor Muir's "History of Chemical Theories and Laws" does not profess to be a history of the whole science; to use the author's own words:

> The more I try to understand chemistry, the more I am convinced that the methods, achievements, and aims of the science can be realized only by him who has followed the gradual development of chemical ideas. . . . I have not attempted the uncalled for task of writing a history of chemistry. The object of this book is to set forth what seem to me the main lines along which the science of chemistry has advanced to its present position. . . . As the purpose of this book is to show how the main conceptions of chemistry have arisen, widened, strengthened, gained or lost ground, this purpose will be better served by taking changes in the general ideas of the science as the landmarks, than by arranging the history of the subject in chronological periods. . . . The development of chemical principles is regarded in this book from the position of to-day. The book is not an attempt to move through the past without knowing whereto the course of the science is tending.

It is, in a sense, therefore, a history of chemical philosophy, arranged so that one set of historically related conceptions after another is followed to its latest developments. The author's plan, of choosing certain lines, has the further advantage that his material is selected, and not, as in the general histories, in large measure thrust upon him by the mere fact of its existence. He is thus enabled to enlarge upon the topics and periods which interest him, and therefore to dwell upon them at such length that the interest of the reader has a chance to be thoroughly awakened also.

In the opening chapter, dealing with the ante-oxygen era, and in many places throughout the rest of the book, the author's well-known familiarity with and interest in the ideas of the alchemists and early chemists provide him with a fertile background and, later, aid him in maintaining the perspective as the work develops. The chemical reformation initiated by Lavoisier, with his recognition of the existence of distinct substances and

their constitution as either elementary or compound, the work of Dalton, and the differentiation of atom and molecule, with all the history which is implied by these phrases, occupy three long chapters. Three briefer chapters dealing with the extension of Avogadro's hypothesis to dilute solutions, allotropy and the inert elements, together with an appendix on nomenclature, complete the first part of the book. This part (200 pages) deals, therefore, with the evolution of the conception of the substance and of all that is connoted by the terms atom and molecule.

The second and longer part deals with chemical interaction in the broadest sense of the term. The first section of this part treats, in six chapters, of the classification of substances by their chemical properties, molecular structure as an expression of chemical behavior, and the periodic system as the basis of a formulation of both physical and chemical behavior. It includes also a chapter on ionization in solution and electronic ionization, with a full account of J. J. Thomson's corpuscular hypothesis of the constitution and behavior of atoms. The second section of this part deals with the conditions and laws of chemical change. In one chapter chemical affinity from Newton to Van't Hoff is reviewed. In another, chemical equilibrium is brought down to Ostwald's Faraday Lecture. In the last chapter the relation between chemical and optical properties, from Biot to Perkin, and thermochemistry from Lavoisier to Clarke, are treated with considerable fullness.

As the author says, others might have made a different selection of material—one misses, for example, the work of Werner when valence is discussed—but the selection is on the whole excellent. The feeling of growth and organic inter-relation is kept admirably before the reader. The style is attractive and the mode of presentation lucid and interesting. The book is not only suggestive, but highly readable—there is not a dry page in it. It is not mere book-making, either. Every statement is based upon a careful study of the original literature, and the scholarship of the book is worthy of the author and of the university with which he is connected.

Von Lippmann's "Addresses and other Contributions to the History of the Natural Sciences" is undoubtedly, in many ways, the most interesting volume of the set. It is a reprint, with slight alterations, of thirty-two addresses and articles, written during the past fifteen years, by the versatile director of the sugar refinery of Halle. They are not fugitive papers, but profound historical studies, and their permanent value—evident enough to the reader—is shown by the frequency with which they are quoted by other writers, like von Meyer. They are perfect mines of information and entertainment, and the thanks of all interested in science, and of chemists in particular, is due to the author and publisher for issuing the studies thus, in collected form. The longer articles include systematic surveys of the chemical knowledge of Pliny and Dioskorides, a history of gunpowder and firearms, an abstract and critique of Goethe's "Farbenlehre," and an analysis of Leonardo da Vinci's many-sided attainments, as a man of science and mechanics. In another, the author makes a searching inquiry into Francis Bacon's writings and mode of life, with a view to determining the exact measure of the profound knowledge often attributed to him and, incidentally, to settle the question whether, if Shakespeare himself lacked the education and scholarship shown in the plays, Bacon was, as some believe, the one man of that time who obviously had the requisite qualities, and might therefore have been their author. Just as in the earlier essays the author's extensive reading in Latin, Greek and Mediæval literature fills the reader with astonishment, so here his familiarity with English literary, scientific and philosophical writings is amazing. He quotes, in passing, Harvey's remark, that Bacon wrote, not like a scientific man, but like a Lord Chancellor, and cites Carlyle, Whewell, Mill and dozens of others with bewildering appositeness. The author is undoubtedly the Andrew Lang of science. This article leads naturally to another containing a systematic account of the scientific knowl-

edge found in the works of Shakespeare. The volume closes with a biographical and critical estimate of Descartes, and a similar account of Robert Mayer, his life, and the trials which he experienced in the promulgation of his views on energy.

The same wide knowledge of curious matters pertaining to science pervades the briefer articles, even the titles of which can not all be quoted. Saint Augustin on quicklime, the superstitions connected with the mandragora, the mystery of the "coasts of Bohemia" (Winter's tale), which is solved by a remark encountered while reading for his "History of Sugar," are all delightful. A note on Who introduced the experiment of burning of a watch spring in oxygen, shows that it was Jan Ingen-Housz (1730–1799), better known as the discoverer of the fact that plants breathe oxygen and generate carbonic acid, in addition to assimilating the latter as food. Amongst the other papers are interesting biographies of Marggraf and Achard, and a curious report on the profits which Edward Howard (brother of the Duke of Norfolk) derived from the invention of the vacuum evaporating apparatus. Several articles deal with subjects connected with sugar. But the author is more than a sugar-chemist and his book can be recommended most heartily to all who are interested in the history of science.

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Die Zustandsgleichung der Gase und Flüssigkeiten und die Kontinuitätstheorie. Von Professor Dr. J. P. Kuenen in Leiden. Braunschweig, F. Vieweg und Sohn. 1907. Pp. x + 241.

Professor J. P. Kuenen, now at Leyden, and recently at University College, Dundee, is a man whose experience has peculiarly fitted him for the task of writing this book, as might be inferred from an examination of the book itself. The "equation of state" which was devised by J. D. van der Waals, of Amsterdam, in 1873, and which bears his name, is an equation which attempts to give in a compact form, the laws controlling the variations of volume, pressure and temperature of all gases, not only when they are far removed from the critical condition, but even at and near the critical point as well. It is usually written

$$(p + a/v^2)(v - b) = RT$$

where a, b and R are constants for any one gas, and p is the pressure, v the volume of unit mass, or specific volume, and T is the absolute temperature of the gas. This equation is a vast improvement over anything that preceded it, particularly the equation of so-called perfect or ideal gases, representing Boyle's and Charles's laws, and is a landmark in the history of physics, but it nevertheless does not represent the facts with complete success. It seems indeed as if it must always remain impossible to represent by one equation containing only a moderate number of constants, the complexity of real gases, for real gases are simple only when compared with liquids or solids, or when their complexities are overlooked, and we regard merely their most important characteristics. The equation has, however, been of marked service in showing the relation between different gases, and between various phenomena of gases, particularly those connected with their behavior when near the critical point, and when they depart most from the simple laws of ideal gases.

Professor Kuenen's book begins with a general statement of the phenomena attending the condensation of gases into liquids. He shows how the elementary kinetic theory of gases explains their behavior when far above the critical point. He then shows, following van der Waals, how this simple theory may be modified by a consideration of the finite size of the molecules of a gas and the forces of attraction which may exist between them. The equation of state having been obtained, it may be used to throw considerable light on the phenomena of condensation, conditions of unstable equilibrium, etc. Several chapters are devoted to what is perhaps the most important thing to be considered, the agreement between the equation and experimental facts. In these chapters are considered the law of corresponding states, critical constants, behavior at high pressure, saturation pressures, Joule-Kelvin researches, specific heats, etc.